Instructor Resources

Representation in STEM: A Textbook Analysis

Created by:

Description

In this activity, students read select portions of a research article dissecting representation within introductory science textbooks. Students scan textbooks for graphic depictions of scientists, analyze the themes, draw predictive graphs, and then discuss/critically analyze the results from the peer-reviewed article to compare to their own predictions. Students then design an experiment to test their predictions based on the conclusions of the article

Learning Goals

1. Students will understand how images and depictions of scientists in textbooks shape societal perceptions of who can become a scientist.
2. Students will understand the interconnectedness of science and society
3. Students will engage with primary scientific literature, evaluate figures, and generate predictions based on data

Learning Objectives

1. Identify how textbook representation of scientists have changed over time.
2. Explain how representation in textbooks shapes student perceptions of who can be scientists.
3. Interpret graphical representation of data
4. Describe how images of scientific representation shape societal perceptions and biases of scientists (or who can be scientists).
5. Design an experiment using the scientific method

Biological Concepts

1. Interpretation and critical evaluation of graphical data.
2. The Experimental Method and Experimental Design.

Scientific Processing Skills:	Reading Research Papers, Reviewing Prior Research, Formulating Hypotheses, Designing Experiments, Predicting Outcomes, Interpreting Results
Pedagogical Approaches:	Concept Maps, Pre/Post Questions, Group Work, Group Discussion
Bloom's Cognitive Levels:	Foundational, Application and Analysis, Synthesis/Evaluation/Creation
Principles of how People Learn:	Leverages Differences Among Learners, Requires Student to do the Bulk of the Work, Develops Supportive Community of Learners
Vision and Change Competencies:	Ability to Tap into the Interdisciplinary Nature of Science, Ability to Communicate and Collaborate with Other Disciplines, Ability to Understand the Relationship between Science and Society

Implementation Guide

10 minutes	**Introductory Slideshow**: The scientific method, the limitations of science, pseudoscience, and experimental design
5 minutes	Read and discuss page one of the activity (introduction from peer-reviewed article)
15 minutes	Fill in the table on page two of the activity
5 minutes	Class discussion: What do the photos recorded in page two imply about the types of people who do science?
10 minutes	Complete page 3 of your activity making predictive graphs
5 minutes	Go over results from peer-reviewed article and compare to student predictive graphs
15 minutes (or homework assignment)	Complete page 4 of the activity (design an experiment)
5 minutes	Class wrap up: Big picture point... we are lacking representation in biology textbooks!

Student Handout

Representation in STEM: A Textbook Analysis

Name: Date:

Notes:

Wood S, Henning JA, Chen L, et al. A scientist like me: demographic analysis of biology textbooks reveals both progress and long-term lags. *Proceedings of the Royal Society B: Biological Sciences*. 2020;287(1929):20200877. doi:10.1098/rspb.2020.0877

"Textbooks are one of the primary resources that undergraduate students use to learn science and are often required reading as part of coursework [1]. While conveying foundational concepts in a given discipline, textbooks highlight the historical work of influential scholars who have shaped the field. Whether intentionally or not, textbooks instill readers with ideas about who can contribute to science, technology, engineering or mathematical (STEM) fields [2]. Therefore, textbooks represent an important opportunity to shape students' existing stereotypes of who scientists are, have been and can be.

Student perceptions of who can do science influence their sense of belonging in STEM fields, which in turn affects their performance and retention [3]. Perceptions are shaped by environmental cues within a context, and previous work shows exposure to stereotypical representations of scientists impacts interest in science among women and students of color [4–6]. Cheryan et al. [7] showed that women lost interest in computer science classrooms when objects from the room signaled that computer scientists are 'geeky' men (e.g. Star Trek posters). In this case, objects broadcasted stereotypes about a group, which discouraged people who did not fit that stereotype from pursuing that potential interest. Additionally, the lack of role models or visual representation of people of color may lead to increased imposter syndrome among such groups. Imposter syndrome is the perception that one doesn't deserve their accomplishments, or a sense of intellectual phoniness [8,9]. Thus, without regular exposure to diverse, relatable role models, scientist stereotypes have the potential to be particularly harmful for students who identify with under-represented and/or marginalized groups. By contrast, exposing students to scientists from a diversity of backgrounds and identities has positive impacts on students' interest and achievement in STEM [10–17]. This impact can be long lasting: in one study, biology students exposed to examples of scientists from under-represented groups in class activities reported increased ability to personally relate to scientists up to six months later."

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3. Margolis J, Fisher A, Miller F. 2000 The anatomy of interest: women in undergraduate computer science. Women's Stud. Q. 28, 104–127.
4. Cheryan S, Plaut VC, Handron C, Hudson L. 2013 The stereotypical computer scientist: gendered media representations as a barrier to inclusion for women. Sex Roles. 69, 58–71. (doi:10.1007/s11199- 013-0296-x)
5. DeWitt J, Archer L, Osborne J. 2013 Nerdy, brainy and normal: Children's and parents' constructions of those who are highly engaged with science. Res. Sci. Educ. 43, 1455–1476. (doi:10.1007/s11165-012-9315-0)
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8. Stout JG, Dasgupta N, Hunsinger M, McManus MA. 2011 STEMing the tide: using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). J. Pers. Soc. Psychol. 100, 255–270. (doi:10.1037/a0021385)
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11. Cheryan S, Master A, Meltzoff AN. 2015 Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. Front. Psychol. 6, 1–8. (doi:10.3389/ fpsyg.2015.00049)
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13. Fairlie RW, Hoffmann F, Oreopoulos P. 2011 A community college instructor like me: race and ethnicity interactions in the classroom. Cambridge, MA: National Bureau of Economic Research.
14. Marx DM, Roman JS. 2002 Female role models: protecting women's math test performance. Personal Soc. Psychol Bull. 28, 1183–1193. (doi:10. 1177/01461672022812004)
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16. Schinske J, Cardenas M, Kaliangara J. 2015 Uncovering scientist stereotypes and their relationships with student race and student success in a diverse, community college setting. CBE—Life Sci. Educ. 14, ar35.
17. Steinke J, Lapinski M, Long M, Van Der Maas C, Ryan L, Applegate B. 2009 Seeing oneself as a scientist: media influences and adolescent girls' science career-possible selves. J. Women Minor Sci. Eng. 15, 279–301. (doi:10.1615/ jwomenminorscieneng.v15.i4.10)

Student Handout

Representation in STEM: A Textbook Analysis

Name: Date:

Notes:

1. Find 10 RANDOM photos *of scientists* in your biology textbook.

If the class doesn't have a textbook, find the most recent edition of any introductory biology textbook at the library. As an online option, you may use this open access text, available as a PDF: https://openstax.org/details/books/biology-2e

Helpful tip: If you are using a web-based text, search for key term "Scientist" and scroll through search results to locate scientists.

2. After completing the chart, discuss the following with your group:

What do these photos imply about the types of people who do science?

What is the scientists...	Name (if available):	Perceived gender:	Race:	Age:	Other details on visible appearance:	Activities in the photo:
Photo 1						
Photo 2						
Photo 3						
Photo 4						
Photo 5						
Photo 6						
Photo 7						
Photo 8						
Photo 9						
Photo 10						

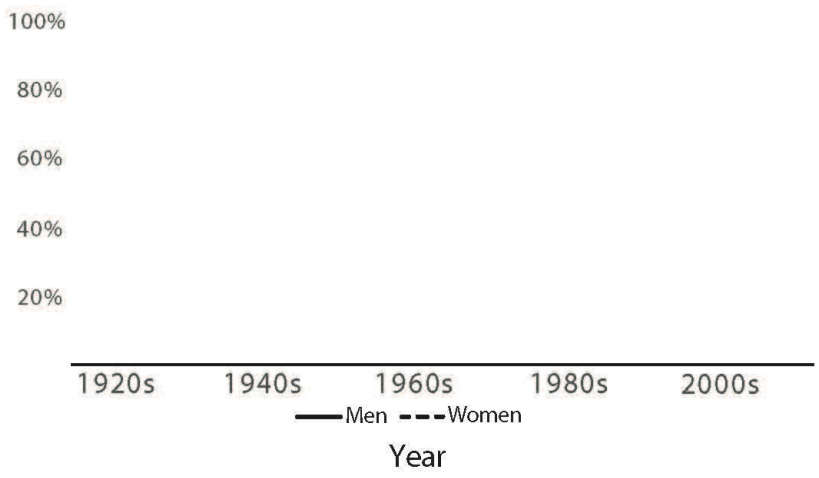
Student Handout

Representation in STEM: A Textbook Analysis

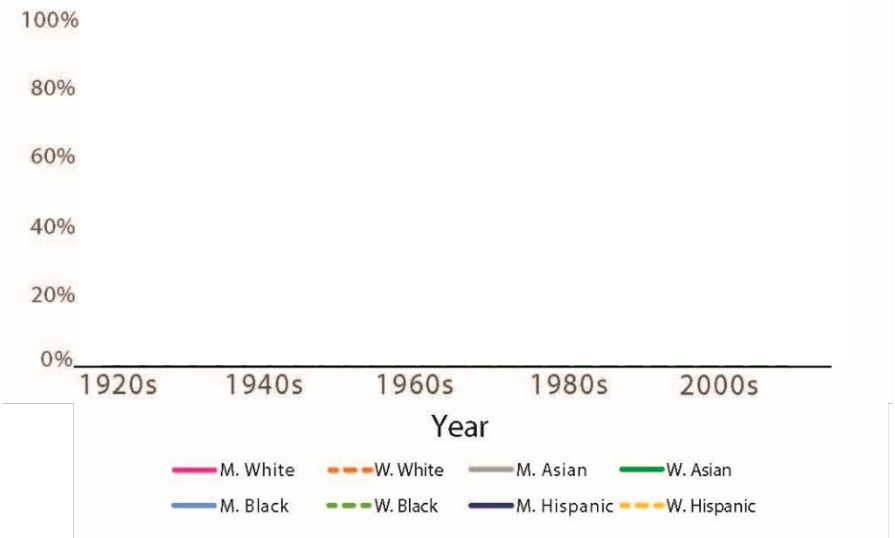
Name: Date:

Notes:

Using your previous knowledge and experience with biology/science textbooks, fill in this graph to depict your prediction of male and female representation in science over time.



Now using colored pencils or labeled lines, depict your prediction of how representation may differ based on race/ethnicity within biology.



Student Assessment

Representation in STEM: A Textbook Analysis

Name: Date:

Use your experience today evaluating peer-reviewed research to design an experiment testing if representation varies by First Generation Student status. Be sure to explain each step of the scientific process. You may use writing, drawings, and graphs to demonstrate your design.

Student Assessment

Representation in STEM: A Textbook Analysis

Name: Date:

1. How do the results from the Wood et al. 2020 paper align (or not) with what you found from an image search of biology textbooks?

2. How did your gender-based prediction compare to the data presented in Wood et al. 2020?

3. How did your predictions based on race/ethnicity compare to the data presented in Wood et al, 2020?

4. How does this impact student perceptions of who can be a scientist? What are the long-term impacts?

List the steps of the scientific method in order.

A hypothesis must be all of the following except:

a. Testable
b. Proven
c. Refutable
d. Precise

Which of the following should be considered when determining scientific validity?

a. Scientific Literacy
b. Biases
c. Means of sharing information
d. All of the above

What type of study is the Wood et al. paper?

a. Descriptive
b. Analytical
c. Correlational
d. Experimental

According to the limitations of science, this study alone tells us whether our current practices are morally right or wrong.

a. True
b. False

If representation in biology and textbook representation are correlated, you can assume one variable leads to another (causation).

a. True
b. False